Green Stormwater Retrofits:

How to identify and prioritize retrofit projects, and then act on them.

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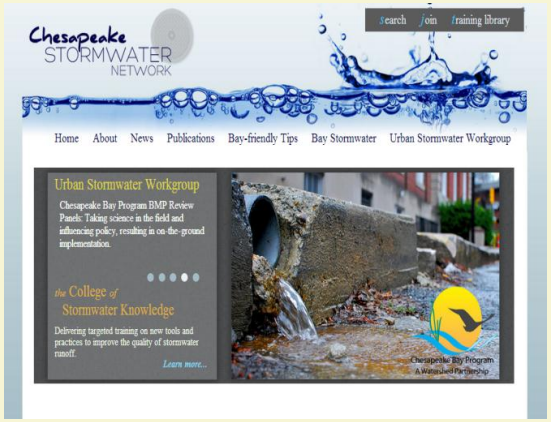
Who we are…

Nonprofit organized to align the local, state, federal and private sectors to solve the Bay stormwater problem through an independent network of concerned stormwater professionals…

- Chesapeake Bay Stormwater Training Partnership
- Network of Stormwater Professionals
- Chesapeake Bay Program



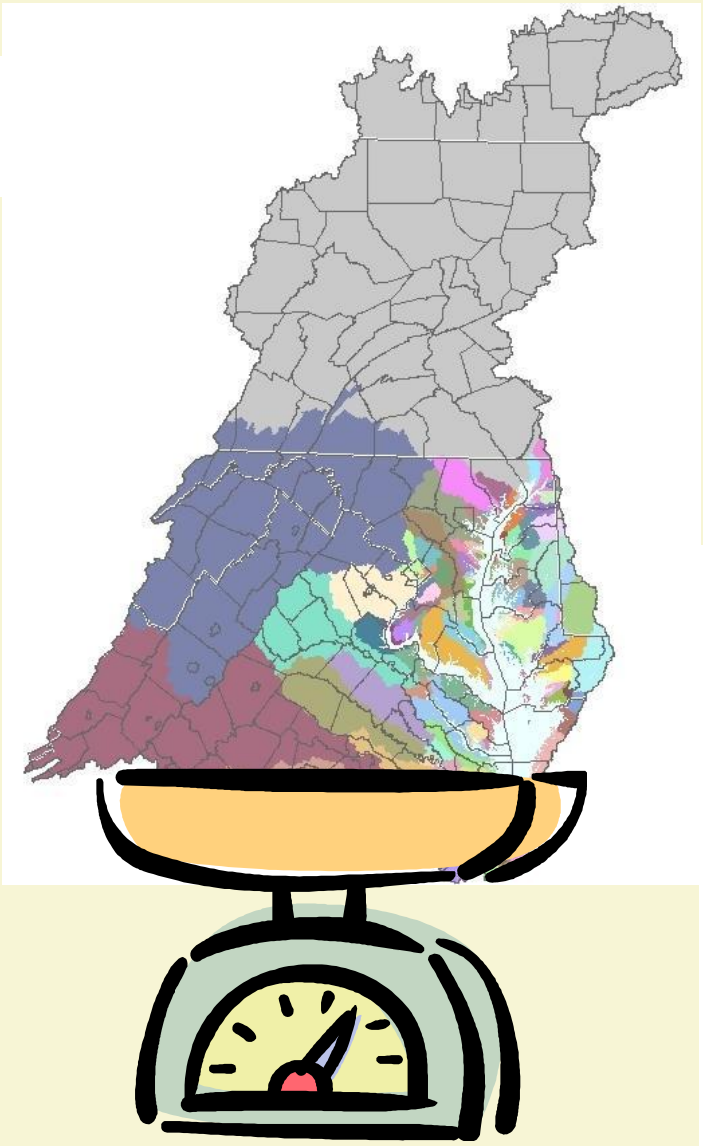
Chesapeake Bay Program
A Watershed Partnership

www.chesapeakestormwater.net

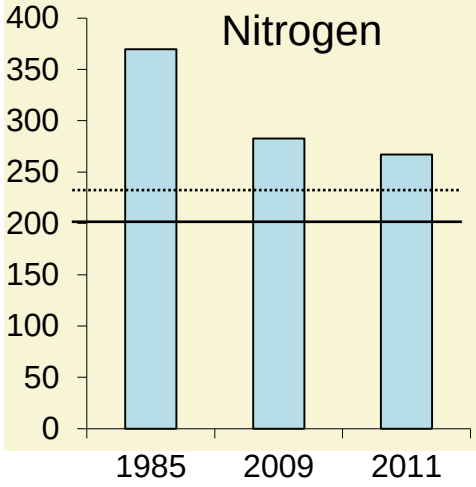
Background on the Bay

- 64,000 mi^2 across 7 jurisdictions
- 2009 Executive Order to "Clean up the Bay"
- Total Maximum Daily Load ≈ "Pollution Diet" for Chesapeake Bay
  - Total Nitrogen (TN)
  - Total Phosphorus (TP)
  - Total Suspended Solids (TSS)

Chesapeake Bay TMDL: Pollution Diet for All Sectors and Sources

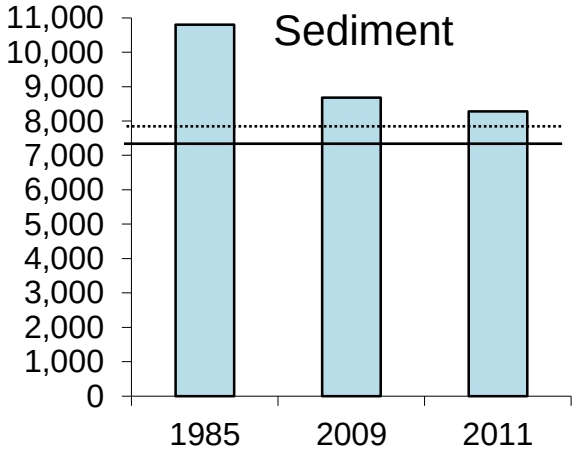


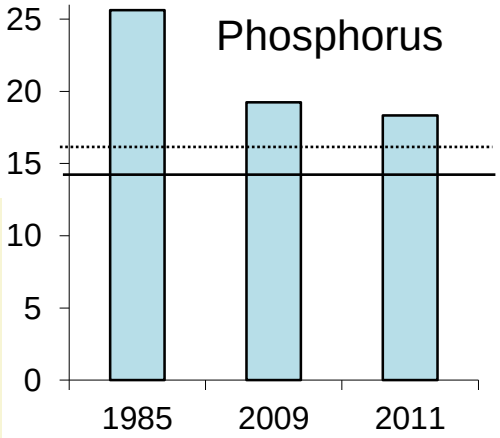
Pollution Delivered to the Bay (million pounds/year)



2017 Interim target

2025 Planning Target (amt. allowed in Bay)



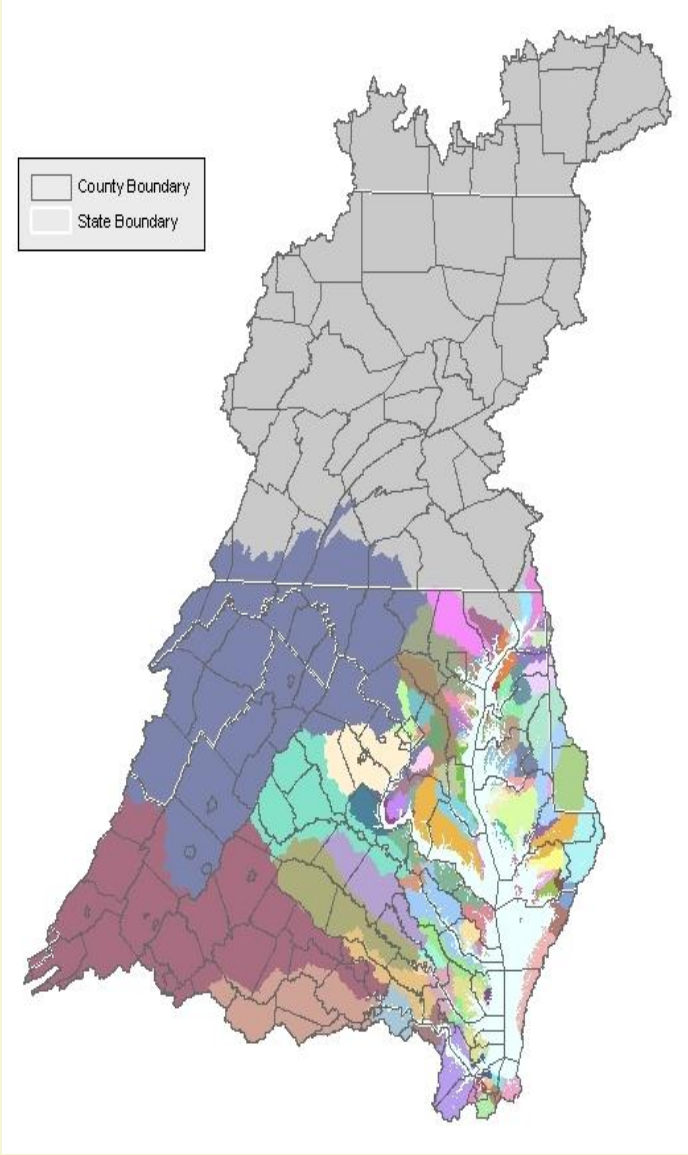


Chesapeake Bay TMDL Based on 7 Watershed Implementation Plans

Jurisdictions required to develop watershed implementation plans (WIPs) to:

- Estimate nutrient and sediment loads
- Identify point and non-point reductions
- Commit to actions, programs, policies

- Two-year milestones provide short-term objectives
- Practices are in place by 2017 to reduce the load by 60%
- **All practices in place by 2025**



Phase II WIP Commitments: Load Reductions from 2009 to 2025

	% Reduction in Statewide Loads			% Reduction in Urban Loads			% Total Load Reductions Attributable to Urban Sector		
	N	P	TSS	N	P	TSS	N	P	TSS
Delaware	26%	31%	27%	13%	12%	5%	4%	2%	5%
D.C.	19%	-68%	5%	13%	22%	16%	5%	N.A.	255%
Maryland	21%	20%	16%	24%	28%	29%	21%	30%	66%
New York	13%	30%	25%	8%	20%	10%	7%	9%	12%
Pennsylvania	30%	29%	28%	41%	45%	50%	20%	24%	39%
Virginia	18%	25%	24%	13%	21%	30%	10%	14%	23%
West Virginia	8%	31%	32%	3%	44%	50%	6%	18%	37%

Negative values indicate increases in loads from 2009 to Phase II WIP planning targets, typically due to increases in wastewater treatment flow up to design capacity.

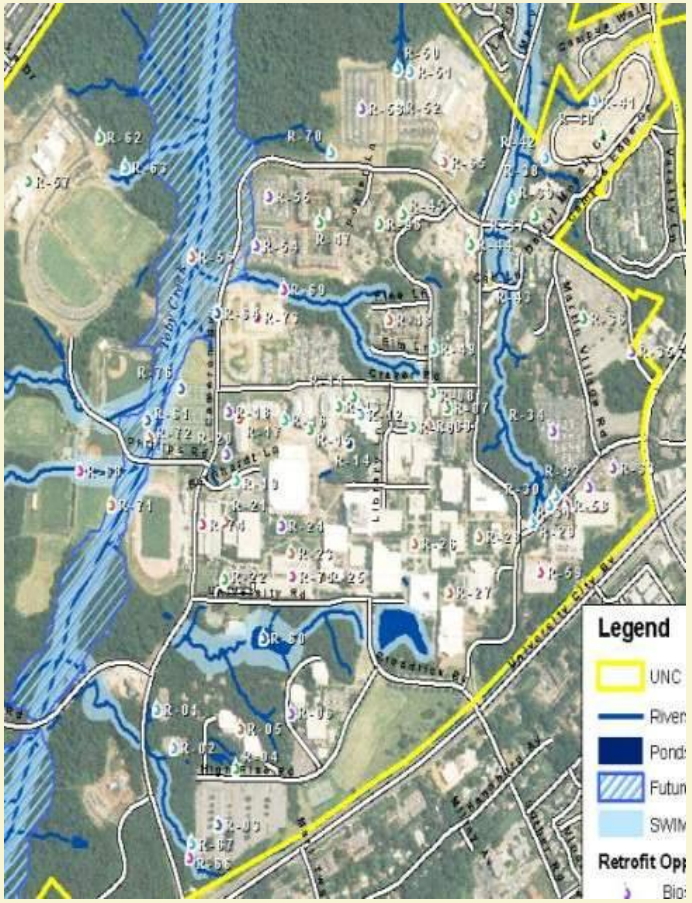
~25 to 30% TP and TN load reductions needed from existing development

How?!

Nutrient Reduction Strategies

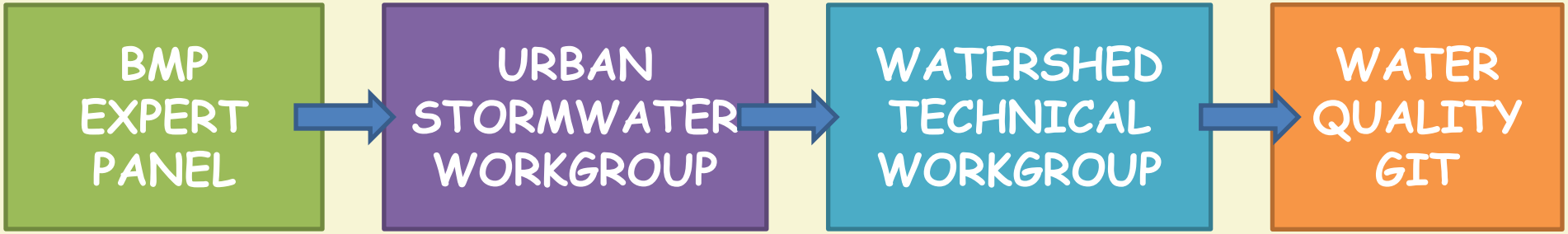
Expert Panel?

1. Comply with new standards ✓
2. Redevelopment Credits ✓
3. Watershed Reforestation ✓
4. Street Cleaning ✓
5. Illicit Discharge Removal ✓
6. P Bans and N Fertilizer Mgmt ✓
7. Stream Restoration ✓
8. BMP Maintenance Upgrades ✓
9. Retrofits ✓



BMP Review Process

- Outlined in the WQGIT BMP Review Protocol (WQGIT, 2010)
- Extensive review of current research
- Identify areas of consensus
- Develop a set of recommendations
- Recommendations used to derive methods and/or protocols to derive nutrient/sediment removal rates



Key panel outcomes

- More retrofit options = more opportunities to get credit!
- Simple to use method for determining pollutant removal!
- Reporting and verification procedures are flexible and can be adapted to align with existing state reporting requirements.
- Not a "one size fits all" approach:

  Each retrofit has its own unique removal rate based on the amount of runoff it treats and the degree of runoff reduction it provides

Retrofit Categories

A. New Retrofit Facilities

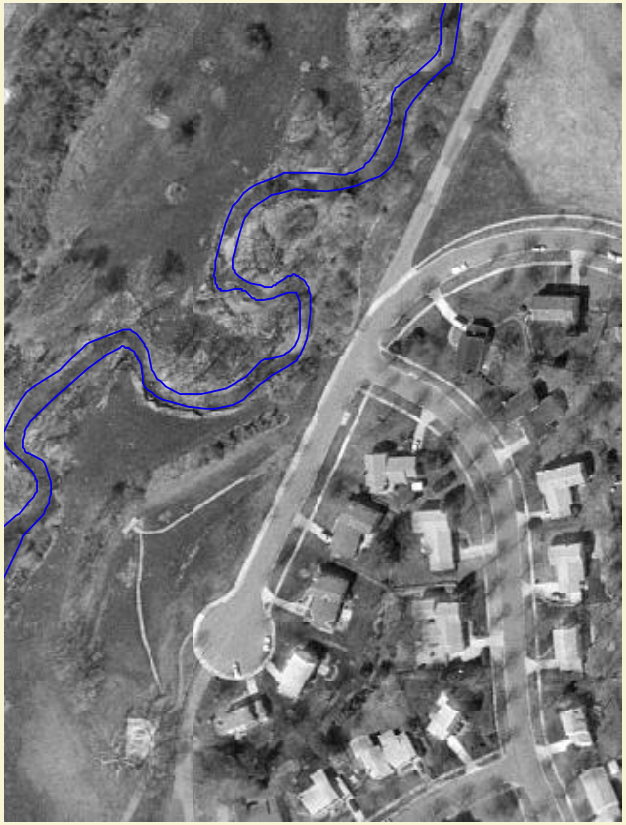
1. Near Existing Stormwater Outfalls
2. Within the Conveyance System
3. Adjacent to Large Parking Lots
4. Green street retrofits
5. On-site LID retrofits

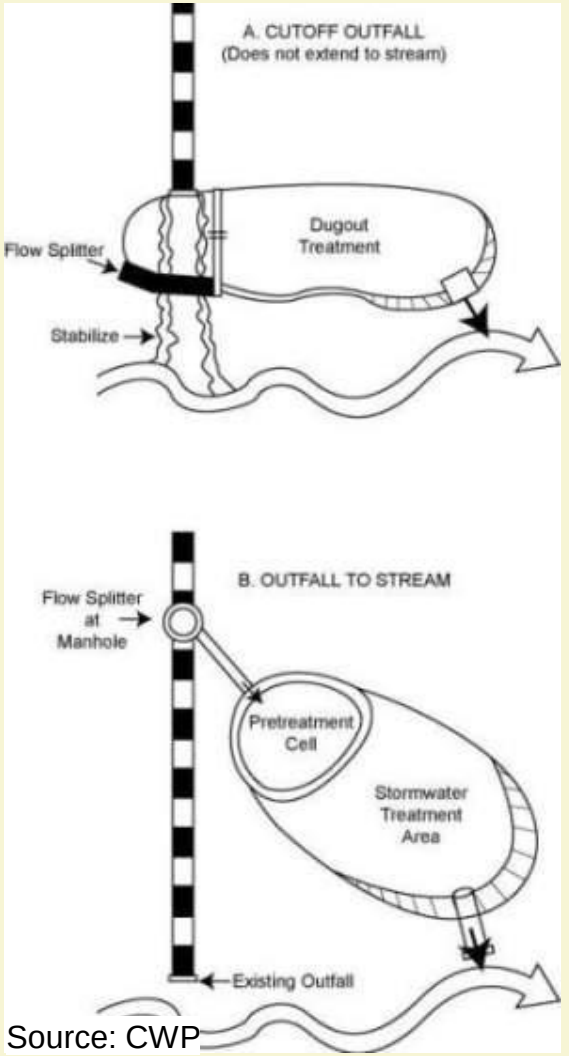
B. Existing BMP Facilities

1. BMP Conversions
2. BMP Enhancements
3. BMP Restoration

NEW RETROFITS

Near Existing Stormwater Outfalls

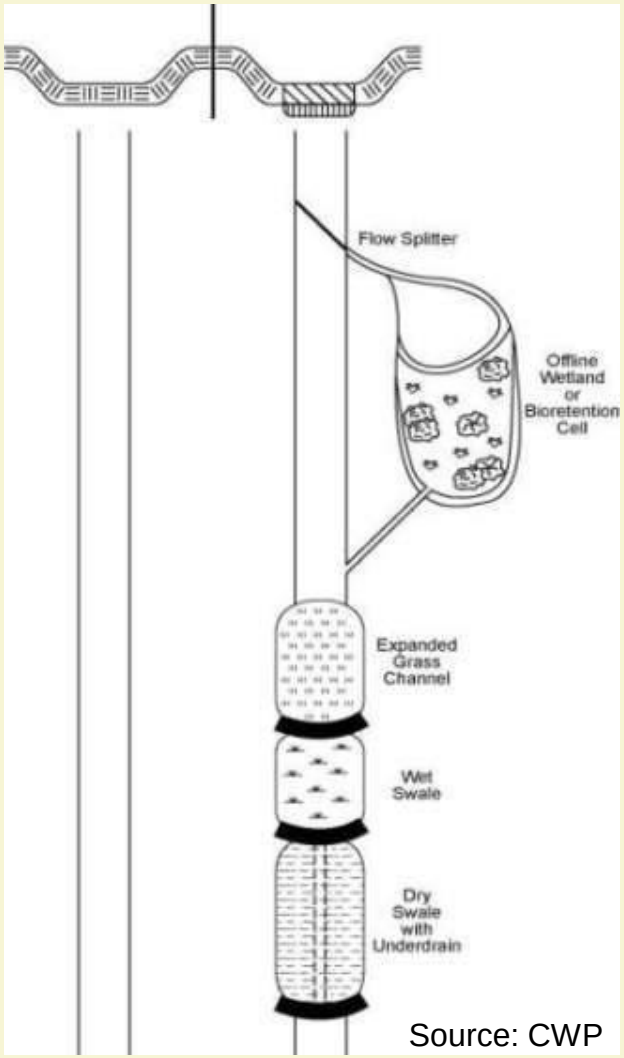




Source: CWP

NEW RETROFITS

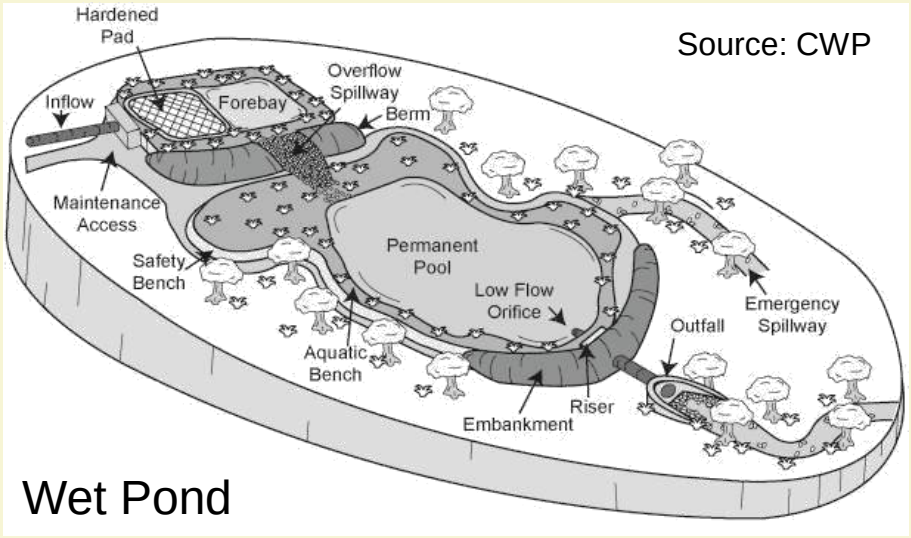
Within the Existing Conveyance System



Source: CWP

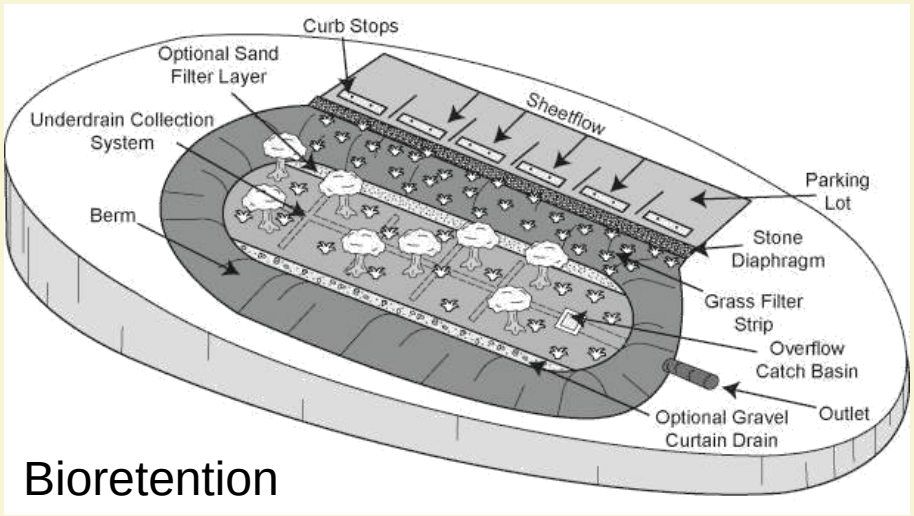
NEW RETROFITS

Adjacent to Large Parking Lots



Source: CWP

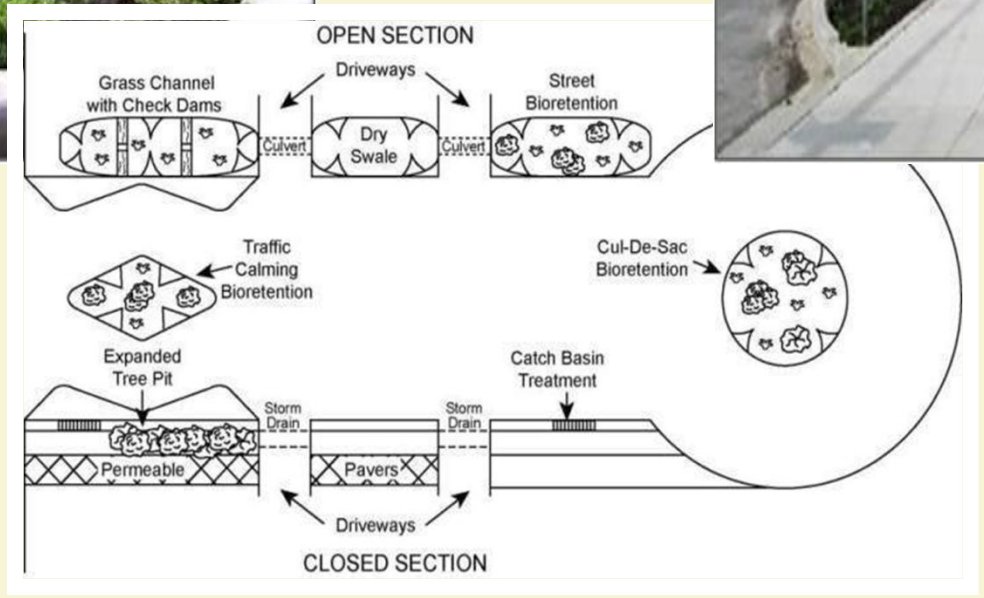
Wet Pond



Bioretention

NEW RETROFITS

Green Street Retrofits



NEW RETROFITS

On-Site LID Retrofits

Retrofit Categories

B. Existing BMP Facilities

1. BMP Conversions
2. BMP Enhancements
3. BMP Restoration

EXISTING RETROFITS

BMP CONVERSION

DRY POND

CONSTRUCTED WETLAND

BMP CONVERSIONS
Rehabilitating Failed Infiltration Practices






BMP CONVERSIONS
Adding Bioretention/Filtering to Ponds

EXISTING RETROFITS

BMP ENHANCEMENT

INCREASE IN HYDRAULIC RETENTION TIME

EXISTING RETROFITS

BMP RESTORATION

MAJOR REPAIRS OR UPGRADES TO EXISTING BMPs THAT HAVE FAILED OR LOST ORIGINAL TREATMENT CAPACITY

BMP RESTORATION
- Qualifying Conditions -

Only 4 types of restoration allowed:

a) Major Sediment Cleanouts
   - Removal of sediment, debris equal to or grater than 1/10 of the volume of the facility

b) Vegetative Harvesting
   - Removal of excessive growth with off-site sequestration

c) Filter Media Enhancements
   - Removal and sequestration of contaminated material and replacement with superior media

d) Complete BMP Rehab
   - Only applies to older BMPs not previously reported

BMP RESTORATION

CAVEATS

- No credit given for routine maintenance
- Restoration activities must restore original capacity of the BMP at a minimum

Removal Rates

BMP removal rates are a function of runoff depth captured and the amount of stormwater treatment (ST) or runoff reduction (RR) achieved by the practice

Runoff Reduction

Runoff reduction is defined as the total volume reduced through canopy interception, soil infiltration, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapotranspiration

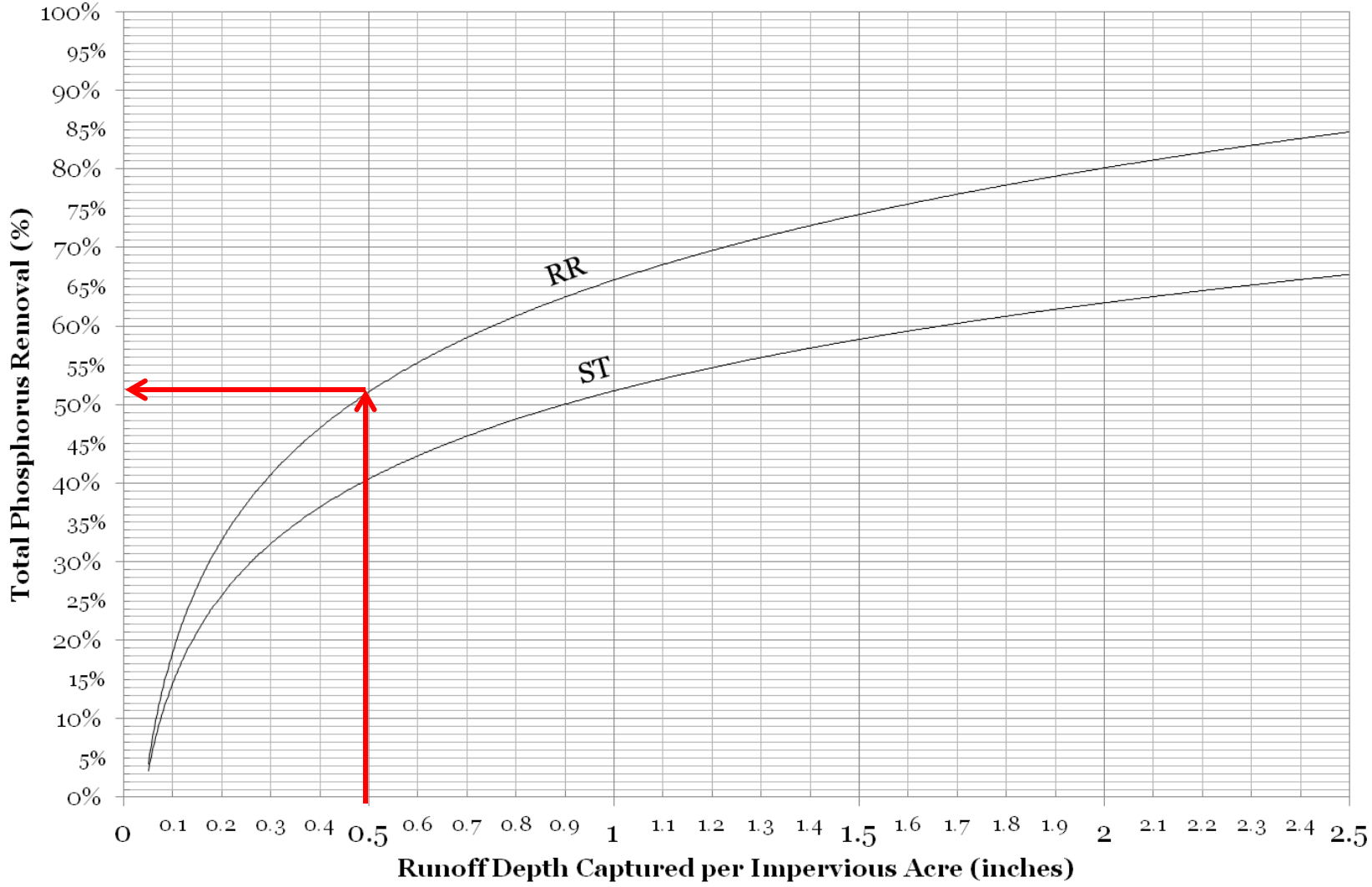
All practices sorted into 2 categories: Runoff Reduction (RR) & Stormwater Treatment (ST)

Classification of BMPs	
Runoff Reduction Practices (RR)	***Stormwater Treatment Practices (ST)***
Bioretention	Constructed Wetlands
Dry Swale	Filtering Practices
Infiltration	Proprietary Practices
Permeable Pavement	Wet Swale
Green Roof	Wet Ponds

Achieve at least 25% reduction of annual runoff volume

Traditional Practices

Total Phosphorus Removal for RR and ST New Development Practices



8 Re-tool your stormwater maintenance program

Inspect the performance of your existing BMP inventory

Field Research Indicates about 30% of the BMP Inventory needs a makeover

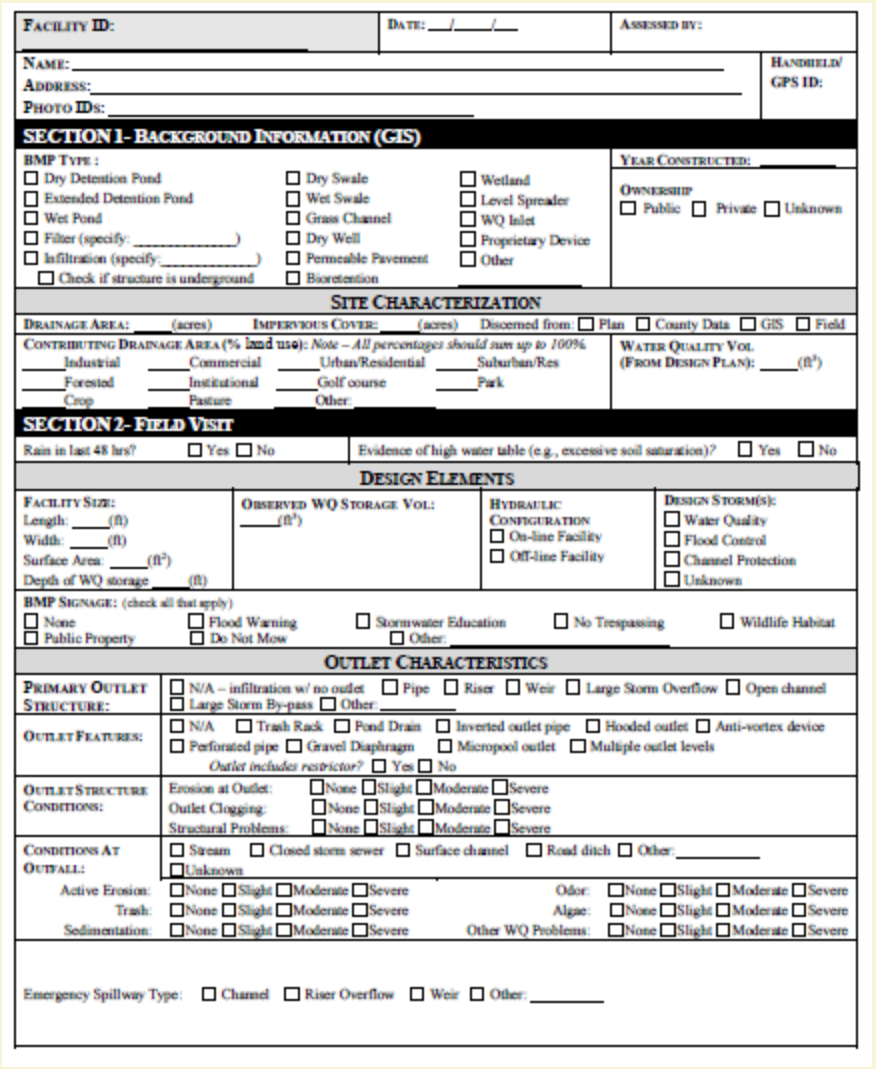
Significant nutrient reductions are possible through these low cost "BMP makeovers"

Performance downgrades must be reflected in local WIP **baseline** load

By Retooling existing Maintenance Budget, it is possible to eliminate eyesores and clean the Bay

BMP Inspections

- "Visual Indicators" technique in order to rapidly assess if a BMP is functioning
- Conducted during every other routine inspection under MS4 permits



FACILITY ID: | DATE: __/____/__ | ASSESSED BY:

NAME: _____

ADDRESS: _____

PHOTO IDS: _____

HANDHELD/ GPS ID:

SECTION 1- BACKGROUND INFORMATION (GIS)

BMP TYPE :

- ☐ Dry Detention Pond
- ☐ Extended Detention Pond
- ☐ Wet Pond
- ☐ Filter (specify: _____)
- ☐ Infiltration (specify: _____)
- ☐ Check if structure is underground
- ☐ Dry Swale
- ☐ Wet Swale
- ☐ Grass Channel
- ☐ Dry Well
- ☐ Permeable Pavement
- ☐ Bioretention
- ☐ Wetland
- ☐ Level Spreader
- ☐ WQ Inlet
- ☐ Proprietary Device
- ☐ Other _____

YEAR CONSTRUCTED: _____

OWNERSHIP ☐ Public ☐ Private ☐ Unknown

SITE CHARACTERIZATION

DRAINAGE AREA: ____(acres) IMPERVIOUS COVER: ____(acres) Discerned from: ☐ Plan ☐ County Data ☐ GIS ☐ Field

CONTRIBUTING DRAINAGE AREA (% land use): *Note – All percentages should sum up to 100%*

____Industrial ____Commercial ____Urban/Residential ____Suburban/Res

____Forested ____Institutional ____Golf course ____Park

____Crop ____Pasture ____Other: _____

WATER QUALITY VOL (FROM DESIGN PLAN): ____(ft^3)

SECTION 2- FIELD VISIT

Rain in last 48 hrs? ☐ Yes ☐ No | Evidence of high water table (e.g., excessive soil saturation)? ☐ Yes ☐ No

DESIGN ELEMENTS

FACILITY SIZE:
Length: ____(ft)
Width: ____(ft)
Surface Area: ____(ft^2)
Depth of WQ storage ____(ft)

OBSERVED WQ STORAGE VOL: ____(ft^3)

HYDRAULIC CONFIGURATION
☐ On-line Facility
☐ Off-line Facility

DESIGN STORM(S):
☐ Water Quality
☐ Flood Control
☐ Channel Protection
☐ Unknown

BMP SIGNAGE: (check all that apply)
☐ None ☐ Flood Warning ☐ Stormwater Education ☐ No Trespassing ☐ Wildlife Habitat
☐ Public Property ☐ Do Not Mow ☐ Other: _____

OUTLET CHARACTERISTICS

PRIMARY OUTLET STRUCTURE:
☐ N/A – infiltration w/ no outlet ☐ Pipe ☐ Riser ☐ Weir ☐ Large Storm Overflow ☐ Open channel
☐ Large Storm By-pass ☐ Other: _____

OUTLET FEATURES:
☐ N/A ☐ Trash Rack ☐ Pond Drain ☐ Inverted outlet pipe ☐ Hooded outlet ☐ Anti-vortex device
☐ Perforated pipe ☐ Gravel Diaphragm ☐ Micropool outlet ☐ Multiple outlet levels
Outlet includes restrictor? ☐ Yes ☐ No

OUTLET STRUCTURE CONDITIONS:
Erosion at Outlet: ☐None ☐Slight ☐Moderate ☐Severe
Outlet Clogging: ☐None ☐Slight ☐Moderate ☐Severe
Structural Problems: ☐None ☐Slight ☐Moderate ☐Severe

CONDITIONS AT OUTFALL:
☐ Stream ☐ Closed storm sewer ☐ Surface channel ☐ Road ditch ☐ Other: _____
☐ Unknown

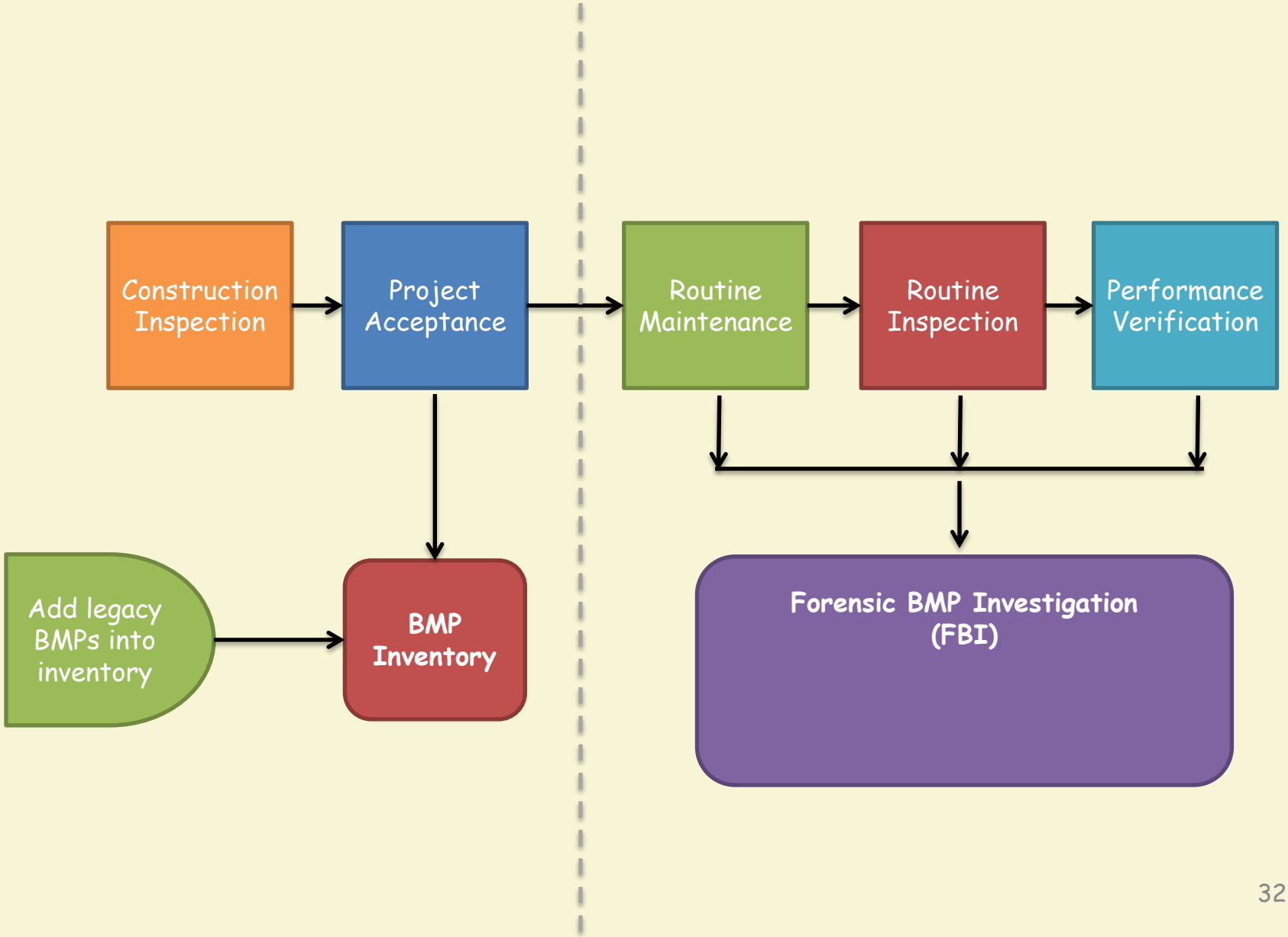
Active Erosion: ☐None ☐Slight ☐Moderate ☐Severe
Trash: ☐None ☐Slight ☐Moderate ☐Severe
Sedimentation: ☐None ☐Slight ☐Moderate ☐Severe
Odor: ☐None ☐Slight ☐Moderate ☐Severe
Algae: ☐None ☐Slight ☐Moderate ☐Severe
Other WQ Problems: ☐None ☐Slight ☐Moderate ☐Severe

Emergency Spillway Type: ☐ Channel ☐ Riser Overflow ☐ Weir ☐ Other: _____

Dealing with the Local BMP Legacy

Thirty Years of BMPs. The BMP Inventory in a Maryland County			
Potentially High Performers		*Known Low Performers*	
Bioretention/Dry Swales	49	Underground Detention	270
Sand Filters	279	Dry Ponds	528
Wet pond	212	Oil Grit Separators	805
Pond Wetland	98	Proprietary Practices	239
Infiltration Basin	58	Flow Splitter	321
Infiltration Trench	459	Other (plunge pools)	30
Adapted from MCDEP 2006			**3350**

Visual Inspection Framework

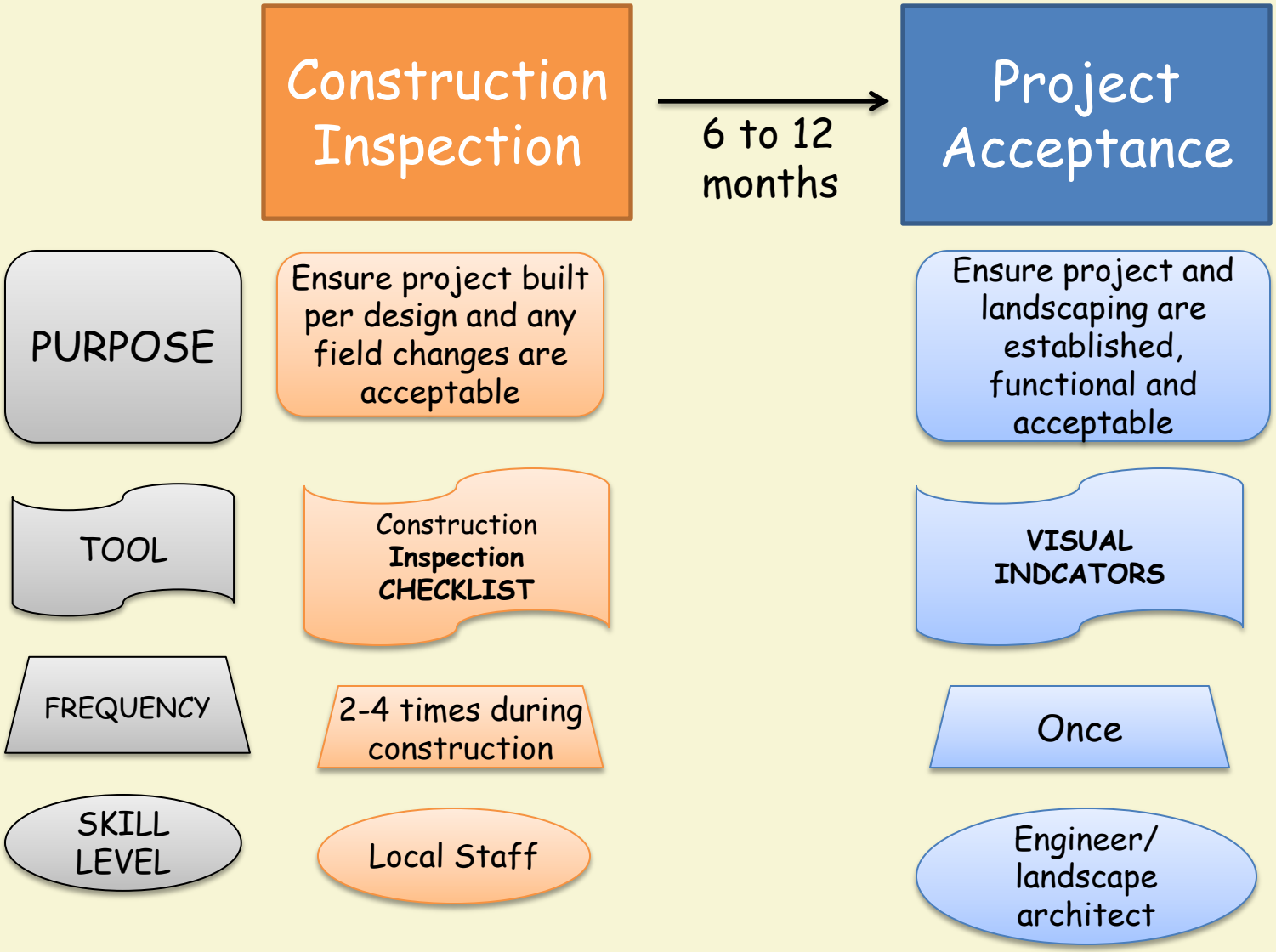


Visual Indicators

Goal: To evaluate the bioretention area in 10 minutes or less

How: Follow a prescribed sequence to assess the performance and functionality of bioretention by using numeric triggers to grade each visual indicator from score of Pass, Minor, Moderate or Severe

Result: Use of a spreadsheet tool to develop a punch-list of tasks to be completed/to follow-up on in order to bring the BMP up to speed



Local Stormwater Management Review Authority

Routine Regulatory Inspection

PURPOSE

Ensure BMP is properly maintained and functioning; Develop a punch list of needed maintenance tasks

AUTHORITY

MS-4 Permit

FREQUENCY

Once ever 1-5 years

SKILL LEVEL

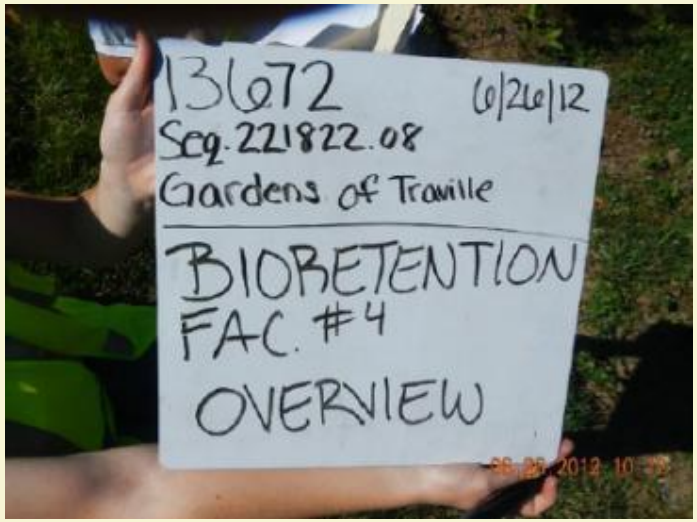
Trained person

Tool:
Visual Indicators

NOTE:
Method should be used to quickly evaluate practice during each routine maintenance visit as well

Field Investigations

- Take photos, measurements, notes
- Use of a dry erase board and a camera to rapidly document the inspection and note observations on a tablet
- Carry simple tools to inspect facilities from ground surface and perform minor maintenance tasks



Visual Indicator Approach for Bioretention

Visual Indicators Sequence

No.	Zone	INDICATOR	
1	Inlet	Inlet Obstruction	
2	Inlet	Erosion at Inlet	INLET ZONE
3	Inlet	Pretreatment	
4	Inlet	Structural Integrity, Safety Features	
5	Perimeter	Surface Area	
6	Perimeter	Side slope Erosion	PERIMETER ZONE
7	Perimeter	Ponding Volume	
8	Bed	Bed Sinking	
9	Bed	Sediment Caking	
10	Bed	Standing Water	
11	Bed	Ponding Depth	BED ZONE
12	Bed	Mulch Depth/Condition	
13	Bed	Trash	
14	Bed	Bed Erosion	
15	Vegetation	Vegetative Cover	
16	Vegetation	Vegetative Condition	VEGETATION ZONE
17	Vegetation	Vegetative Maintenance	
18	Outlet	Outlets, Underdrains, Overflows	OUTLET ZONE

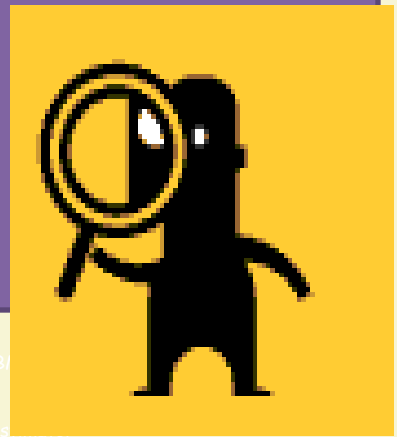
Forensic BMP Investigation
FBI

Purpose: to diagnose why a BMP is not working and how to fix it

Audience: BMP owner

Frequency: as warranted by field inspection

Skill Level: engineer/project estimator



to diagnose why a BMP owner
as needed
engineer/project estimator

Indicate what needs to be checked by private BMP owner in a letter on non-compliance

FBI

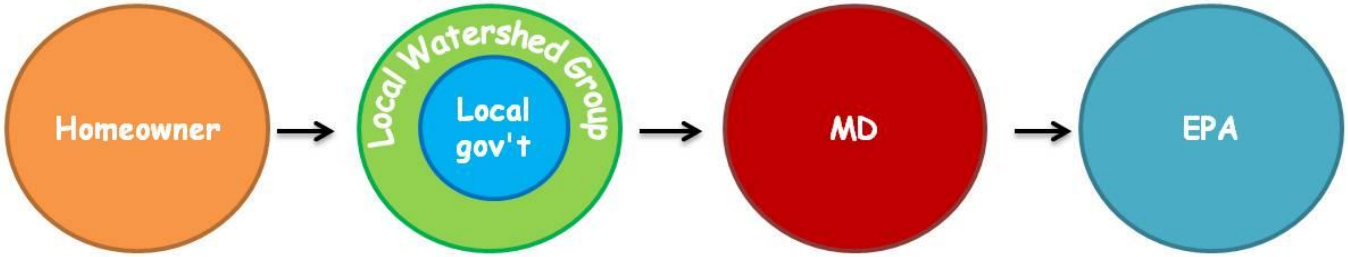
Key Visual Indicators that Trigger an FBI for Bioretention		
No	Indicator	Status
1	Severe Inlet Obstruction	Most runoff cannot enter the facility
4	Structural Integrity	Facility or adjacent infrastructure at risk of failure
2, 6, 14	Severe Inlet Erosion, Sideslope or Bed	A foot or more of gully erosion
7	Severe Design Departures	More than 25% departure from design assumptions for surface area, ponding depth and/or contributing drainage area
8	Severe Bed Sinking	A foot or more of localized bed sinking and/or sediments observed in underdrain
9	Severe Sediment Caking	More than two inches of deposition in the facility
10	Severe Standing Water	More than 3 inches of ponding 72 hours after rain
15	Severe Vegetative Cover	35% of less vegetative cover

Homeowner BMP Crediting

UNM Plan for 9200 Bradford Pear Lane: 0.5 acres		
1	Get Expert Lawn Advice	✓
2	Maintain Dense Cover on Turf	✓
3	Choose NOT to fertilize	✓
4	Recycle Lawn Clippings and Compost Fallen Leaves	✓
5	Correct Fertilizer Timing	N/A
6	Use Slow Release Fertilizer	N/A
7	Set Mower Height at 3 inches	✓
8	No off-target fertilization	N/A
9	Fertilizer free buffer zones around water features	✓
10	Increase soil porosity and infiltration	✓

Urban Nutrient Mgmt
Rain gardens
Rainwater Harvesting
Downspout Disconnection
Tree Planting
Conservation Landscaping
Permeable Driveways

Possible Framework for Piloting Homeowner BMP Crediting in MD



	Homeowner	Local Watershed Group / Local gov't	MD	EPA
ROLE	• Install and maintain BMPs • Report them on website	• Initial verification of BMP installation • Maintain homeowner BMP records and summary tracking database • Ongoing inspection for BMP verification • Homeowner recognition program (*optional*)	• Aggregate locally supplied BMP data, and provide quality control • Modify existing guidance and reporting tools	• Enter into CBP progress runs • Lead BMP crediting team • Review and adopt "Framework for accepting homeowner BMPs"
TOOLS NEEDED TO IMPLEMENT	• Help in measuring lot cover ★ Homeowner BMP toolbox ★ Home self-audit procedure	• Homeowner BMP option added to MDE Draft Guidance (2011) and new BMP reporting system • Homeowner access website template ★ Visual Inspection Protocols	• Need EPA or CBP approved homeowner BMP framework	• Support Expert Panels to develop new homeowner BMPs • Revise Scenario Builder, MAST to deal with homeowner BMPs
WHAT IS REPORTED	• Lot area, by land cover type • Practice Type, Area and Rainfall treated	• BMPs installed • Nutrient Reductions • Year installed	• Summary of local BMP data and expiring BMPs	• Report progress made in nutrient reduction due to homeowner BMPs
VERIFICATION	• Provide contact info • Allow on-site access for inspection	• Conduct visual inspections on prescribed cycle, or allow BMPs to expire	• Ensure local verification occurs, or let BMPs expire	• Develop BMP data metrics to detect BMP reporting anomalies
ROLE IN PILOT	• Provide feedback on customer satisfaction	• Select an existing community offering BMP incentives and a second one who is considering offering an incentive program, as test pilots	• Make sure that the crediting system works administratively	• Depending on pilot, make homeowner BMP framework and tools available to other states

User input
Calculated values
Constants
Default

	USER INFORMATION
NAME	Tom Schueler
ADDRESS 1	1234 Main Street
ADDRESS 2	
CITY	Catonsville
ZIP	21228

SITE DATA			**LOAD GENERATED FROM SITE**	
LOT COVERAGE	Area: ft^2	% of Lot	TN Load	TP Load
Impervious Cover				
Rooftop	3360	15%	1.18	0.13
Driveway/Sidewalk	2790	13%	0.98	0.11
Total	**6150**	28%	**2.16**	**0.24**
Pervious Cover				
Trees/Landscaping	5500	25%	1.36	0.05
Rain Garden/BMP	600	3%	0.15	0.01
Lawn	9530	44%	2.36	0.09
Total	15630	72%	**3.88**	**0.15**
TOTAL	**21780**	**100%**	**6.04**	**0.39**

Homeowner uploads basic data to local web site

Other tools to manage and aggregate homeowner BMP from local and state databases directly into CBWM

Removal rates are based on expert panel reports

Next Steps

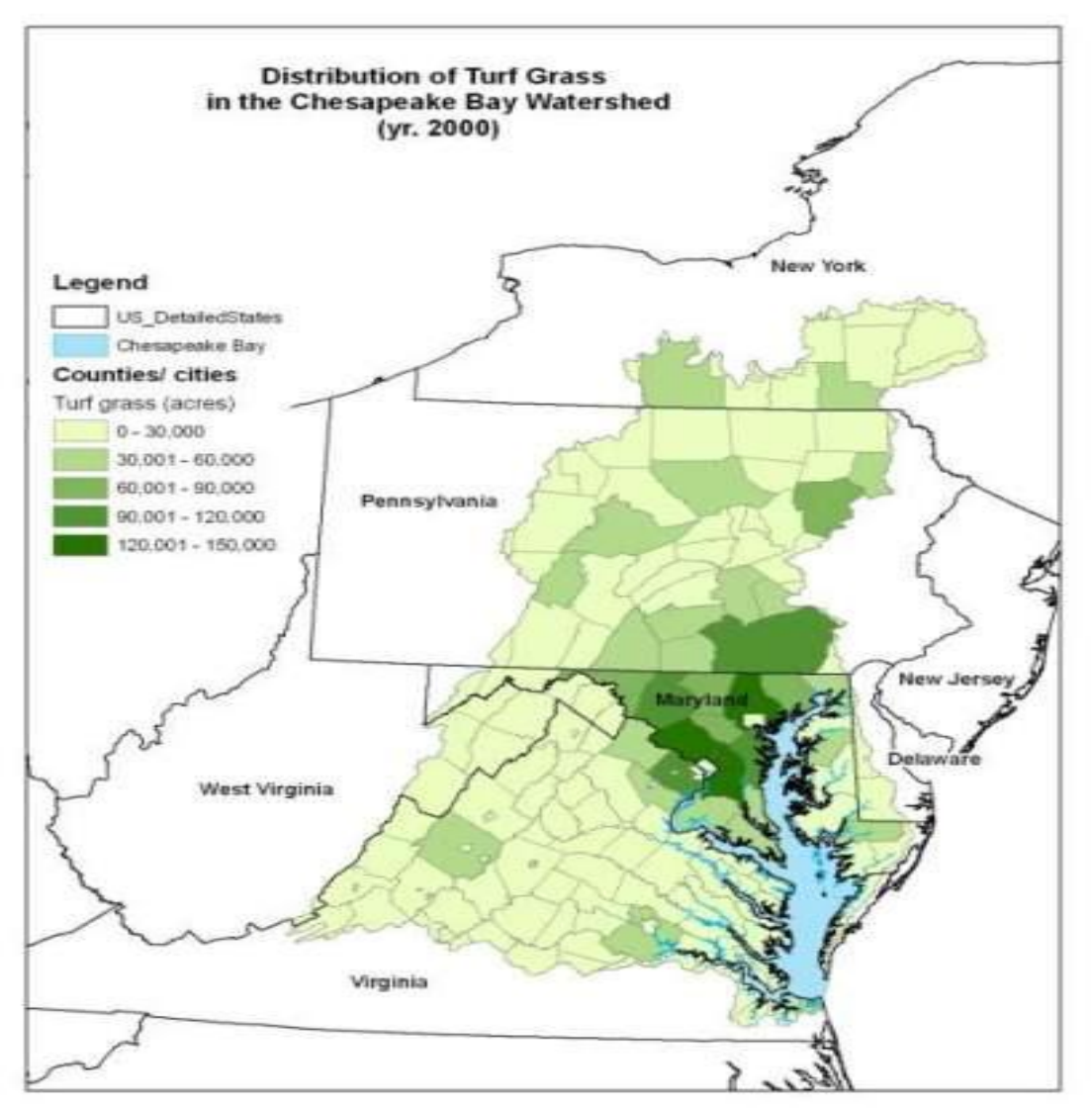
- Conduct pilots in MD in 2013 to test tools, data management issues and verification capacity (MDE)
- Homeowner BMP guide (Riverwise/CSN)
- Ad hoc crediting team (EPA CBPO)
- Bay-wide rollout to take credit for 2014 progress runs

Homeowner BMP Delivery Issues

- Expand to non-residential properties
- Link to local BMP incentive/subsidy programs
- Credit BMPs installed to reduce stormwater utility fees
- Training of on-site homeowner BMP evaluators
- Link to other practices inside the home (e.g., energy conservation)

Updates on other Nutrient Reduction Methods

Urban Nutrient Management



1.5 million acres of home lawn are fertilized in the watershed

CURRENT EXPERT PANEL

Three UNM Credits

- Automatic State-wide P Reduction Credit for P Ban Legislation
- Contingent State-wide N Reduction Credit based on Sales
- N and P Reductions for Qualifying UNM Plans

Automatic TP Load Reduction Credit from Pervious Lands for States that HAVE adopted P fertilizer legislation

Bay State	TP Reduction (million pounds)	% Change in Pervious Load	% Change in Urban Load
MD	0.060	- **25.1**	**- 8.6**
NY	0.012	- 26.5	- 11.6
VA	0.125	- 26.7	- 10.2

[1] 2010 Delivered Loads
Source: Gary Shenk, CBPO, April 10, 2012 spreadsheet of CBWM 5.3.2. model runs assuming 0% P application rates

Assumed 70% Reduction in TP fertilizer Inputs to CBWM

Core UNM Practices for the Chesapeake Bay

1. Get *technical assistance* to develop an effective UNM plan for the property
2. Maintain a **dense** vegetative cover of turf grass or conservation landscaping
3. Choose not to fertilize, **OR** adopt a reduce rate/monitor approach **OR** the use the small fertilizer dose approach
4. Retain clippings and mulched leaves on the yard and keep them out of streets and storm drains
5. Do not apply fertilizer before spring green up or after Halloween*

Meaningless Photo to Break up Monotonous Word Slides

Core UNM Practices for the Chesapeake Bay

6. Maximize use of slow release N fertilizer during the active growing season
7. Set mower height at 3 inches or taller
8. Immediately sweep off any fertilizer that lands on a paved surface
9. Do not apply fertilizer within 20 feet of a water feature and manage this zone as a perennial planting, a tall grass buffer or a forested buffer
10. Employ lawn practices to increase soil porosity and infiltration capability and use the lawn to treat stormwater runoff.

High Risk Export Factors

Pervious areas subject to one or more of the following risk factors:

- Currently over-fertilized beyond state or extension recommendations
- P-saturated soils as determined by a soil P test
- Newly established turf (i.e., less than three years old)
- Steep slopes
- Exposed soil
- High water table
- Over-irrigated lawns
- Soils that are sandy, shallow, compacted or have low water holding capacity
- High use areas (e.g., athletic fields, golf courses)
- Adjacent to stream, river or Bay
- Karst terrain

More specific "operational definitions" provided for each risk factor

Nitrogen Reduction Credits
for Qualifying UNM Plans Per Acre of Residential, Commercial, Institutional or Public Land

Turf Nitrogen Management Category	Annual Nitrogen Reduction Rate
Low Risk Lawns [1]	6 % reduction of pervious load
Hi Risk Lawns [1]	20% reduction of pervious load
Blended Rate [2]	9% reduction of pervious load

[1] regardless of fertilization regime (including non-fertilized lawns
[2] state-wide credit, assuming 80% of lawn acreage falls into the low category and 20% is high risk

Phosphorus Reduction Credits
for Qualifying UNM Plans Per Acre of Residential, Commercial, Institutional or Public Land

Turf Management Category [1]	Annual TP Reduction Rate [1]
Low Risk Lawns	3 % reduction of pervious load
Hi Risk Lawns	10 % reduction of pervious load
Blended Rate	4.5% reduction of pervious land

[1] regardless of fertilization regime (including non-fertilized lawns
[2] state-wide credit, assuming 80% of lawn acreage falls into the low category and 20% is high risk

Urban Stream Restoration

- High nutrient reduction rates for qualifying projects
- Provides both a local benefit and a Bay benefit
- Generally popular with the public
- Cost competitive with pond retrofits

CURRENT EXPERT PANEL

Proposed Interim Stream Restoration Rate

Removal rate per Linear foot of Qualifying Stream Restoration			
Source	TN	TP	TSS
CBP 2005 N=1	0.02 lbs	0.0035	2.55 lbs
CSN 2011 N=6	0.20 lbs	0.068 lbs	310 lbs
Expert Panel	See Next Slides		

Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Four Stream Restoration Protocols

- *Protocol 1: Credit for Prevented Sediment During Storm Flow* -- This protocol provides an annual mass nutrient and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream.

- *Protocol 4: Credit for Dry Channel Regenerative Stormwater Conveyance (RSC) as Upland Retrofit* -- This protocol provides an annual mass nutrient and sediment removal rate for this class of projects using the adjustor rate removal curves developed by the stormwater retrofit expert panel.

Four Stream Restoration Protocols

- *Protocol 2: Credit for Denitrification in the Hyporheic Zone During Base Flow* -- This protocol provides an annual mass nitrogen reduction credit for qualifying projects using empirical measurements of denitrification during base flow within a stream's hyporheic zone (stream, riparian and floodplain)

- *Protocol 3: Credit for Floodplain Reconnection Volumes During Storm Flow*-- This protocol provides an annual mass nutrient reduction credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events.

Discussion on Prioritization of Retrofits

Resources

- LOTS of Retrofit Resources on web
- New LID Construction, Maintenance and Inspection Resources:
  - TB# 10 Bioretention Illustrated - Any day now!!
  - **Videos** in English & Spanish
  - TB# 11 Designing a Local LID Maintenance Program
- Homeowner BMP Crediting System and Tools

www.chesapeakestormwater.net